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(54) Abstract Title
Sensing corrosivity in a pipeline

(57) The device detects a chemical environment in the pipeline that is likely to cause corrosion of the pipeline, and comprises sensors 6 mounted on a mobile carrier 5 moveable within the pipeline. The sensors may be electrochemical and the carrier may be a pipeline pig. The sensors are mounted in cavities disposed at the peripheral wall of the carrier, which also contains either a recording device 7 or a device for transmitting data to a location outside the pipeline, so that measurements can be made at locations along the pipeline. The measurements may be of water in oil, and an assessment of the possibility of corrosion can be made. The pig can be propelled by flow of fluid in the pipe, by remote control, or by the application of an external force.

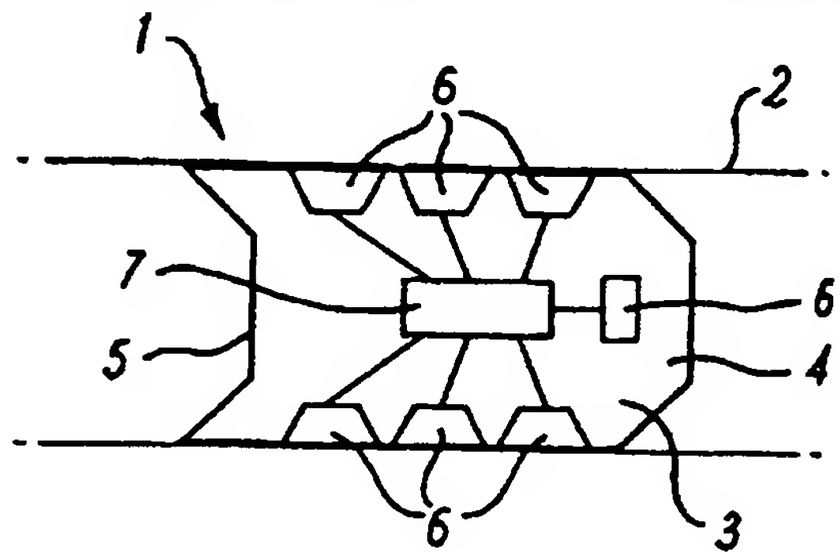

FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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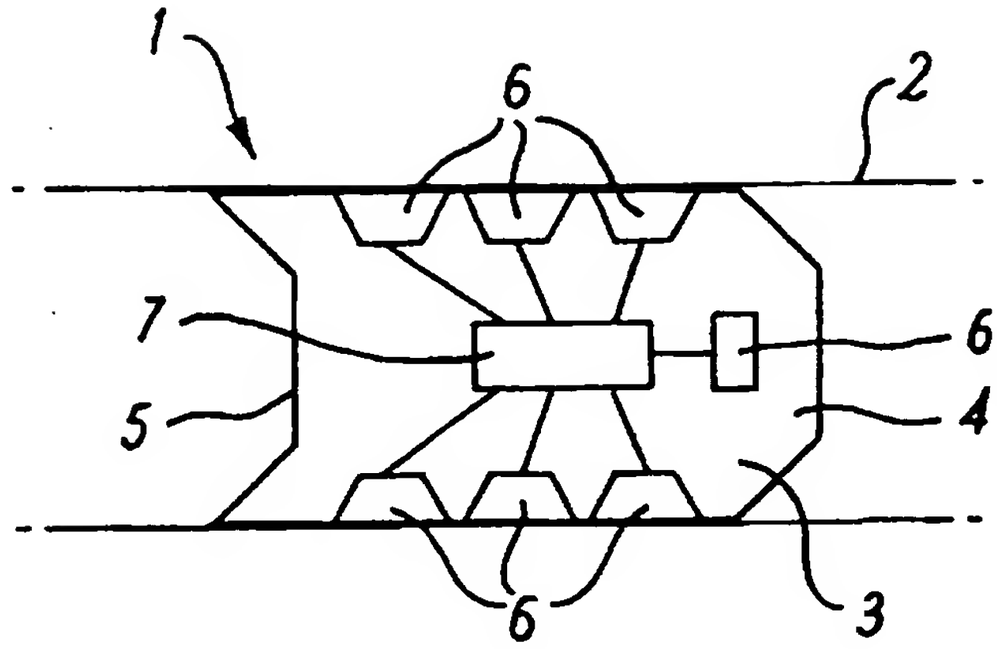

FIG. 1

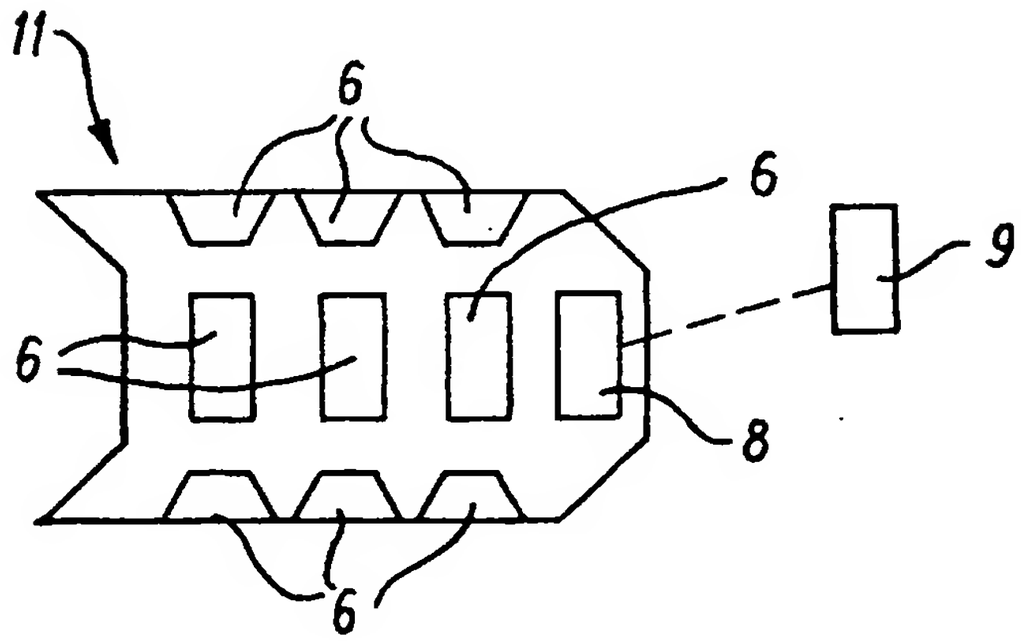

FIG. 2

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APPARATUS AND METHOD FOR SENSING CORROSIVITY IN A PIPELINE

This invention relates to the detection of corrosivity in a pipeline or tubing.

The occurrence of corrosion in pipelines continues to give rise to substantial maintenance costs and inefficiencies. Typically, corrosion will begin on the inside of a pipe and thus will not become apparent to an external examination until it has penetrated through the pipe wall, at which time any medium or fluid being conveyed in the pipe may leak and maintenance is required urgently. For this reason it has been found beneficial to devise means for conducting internal examinations within a pipeline or the like to detect for corrosion.

In the past such examinations have involved a variety of equipment and methodology. One common method involves the measuring or at least detecting of irregularities on the internal surface of a pipeline. For example, US Patent 4,541,278 teaches the use of sensors mounted on a pipeline pig to measure physical irregularities. The sensing device comprises the use of radial, spring-loaded

fingers that maintain constant contact with the interior of the pipe. The fingers are acoustically linked to microphones inside a liquid tight drum. A recording device records the audio signals picked up by the microphones.

In practice, this device is likely to give inaccurate results at best; there being an inexact correlation between the audio signals and the integrity of the pipe wall. The lack of sensitivity of the microphones makes measurement of trace imperfections very difficult to quantify. A further disadvantage of such apparatus is that the detection device can only be used in one direction and cannot be used to pass the same section repeatedly.

PCT/DE92/01034 teaches the use of an ultrasonic inspection probe to detect abnormalities on the surface of a pipe. The probe slides through the pipe and enables the measurement of a data-compression factor that is used to calculate the extent of the abnormalities.

Other techniques for measuring or detecting corrosion include introducing an electrode near a buried pipeline or other object, applying a charge to the pipeline or object and measuring the decay of the charge to determine the extent of corrosion. A similar technique is taught in US Patent 4,611,175, although not in direct relation to a pipeline. Generally, such techniques are suitable only for detecting the existence of corrosion at fixed locations on a buried structure. Improper or sparse positioning of the charges can cause failure to detect corrosion or an otherwise misrepresentation of the true condition of the pipeline.

US Patent 4,400,782 teaches the use of the pipeline itself as a method of transmitting data signals to a monitoring station. The signals that measure the extent of corrosion are recorded from a plurality of substations placed at intervals along the pipeline. These substations can be very expensive to maintain or replace. In addition, the technique does not give an accurate indication of the location of any impediment or flaw in the pipeline.

Other methods known include the measurement of changes in capacitance, change of speed of a shoe moving through a pipeline and change of strain using spring mechanisms.

However, apart from the disadvantages already described in these and other known methods, they each are designed to merely detect the existence of corrosion only after it has become sufficiently problematic to affect the integrity of the pipeline.

In the present invention it is recognised that it would be far more preferable to detect the imminency of corrosion occurring, yet before it does so occur. It is further recognised in this invention that corrosion becomes probable when certain chemical environments are allowed to exist. Apparatus and method designed to detect the existence of such environments may be employed to warn personnel of potential oxidation reactions occurring.

In US Patent 4,506,540 sensors are used to detect the presence of water or other electrolytes in a dry pipeline, such as a gas line. This is achieved by

measuring the deposition of conductive impurity by a gas on its passage through the pipeline. The sensors comprise of conductive members spaced by an insulating material. The presence of the conductive impurity can be established by measuring its resistance or boiling point. The invention described therein is limited, however, to dry gas lines. In practice, gas lines are frequently made of plastics materials not prone to corrosive attack. In contrast, pipe lines carrying oil and other fluids are required to be of stronger construction and accordingly made of metallic materials in respect of which corrosion is a more real consideration.

It is an object of the present invention to provide a tool to predict the possible onset of corrosion of the interior of a pipeline, while a further object herein is to provide for the tool to be used in a wet pipeline.

A further object of the invention is to provide for the use of a plurality of electromechanical sensors to detect the chemical conditions within a pipeline.

A yet further object of the invention is provide for the use of a mobile pipeline carrier on which the sensors may be mounted such that the invention may sweep the length of the pipeline and record the chemical conditions at a number of locations.

A yet further object herein is to provide apparatus and method for detecting a chemical environment encouraging to corrosive activity in a pipeline or other tubing, wherein the apparatus and method may function during the normal use and operation of the pipeline.

According to a first aspect of the present invention there is provided apparatus for detecting a chemical environment in a pipeline that is likely to cause corrosion of the pipeline wall, wherein the apparatus includes sensors mounted on a mobile carrier moveable within the pipeline.

The carrier may be, but is not limited to, a pipeline pig.

Preferably, the sensors are mounted in cavities disposed at the circumference of the peripheral wall of the carrier. Typically, the apparatus further includes means for communicating information or data detected by the sensors to a remote location outwith the pipeline.

The movement of the pig may be controlled via the flow of fluid through the pipe exerting a force on the pig. Alternatively, the movement of the carrier may be controlled via an external means, for example via the use of a remote control or by the application of an external force.

Preferably, the sensors are electro-chemical sensors.

According to a second aspect of the invention there is provided a method of monitoring the likelihood of corrosive activity in a pipeline or other tubing, the method comprising the steps of positioning one or more electrochemical sensors internally in the pipeline or tubing and detecting the nature of the chemical environment therein.

Preferably the method further involves the movement of the sensors throughout the pipeline to obtain a more complete appraisal of the pipeline condition.

In order to provide a better understanding of the invention, an embodiment will now be described by way of example only, and with reference to the accompanying Figures, in which:

Figure 1 shows a tool in its state of operation according to the invention; and

Figure 2 shows an external view of an alternative tool detailing the positions of the sensors.

Referring firstly to Figure 1, a representation of the tool, generally described at 1, is depicted in a pipeline 2. The tool 1 is comprised of a mobile carrier 3 having a front drive cup 4 and a rear drive cup 5. In the example embodiment shown, the mobile carrier 3 is a pig.

The tool 1 has a plurality of sensors 6 mounted at intervals both circumferentially and axially.

The sensors 6 are electro-chemical sensors, particularly capable of detecting moisture and, more specifically, the ratio of moisture or water in the surrounding environment.

The tool 1 also contains a recording device 7 that is linked to the sensors 6. Thus, in the example embodiment shown in Figure 1, information detected by the sensors 6 is stored in the recording device 7 and may then be

subject to analysis after the pig has been run through the pipeline 2.

In the tool 11 of Figure 2, however, the recording device is replaced by a transmitter 8 adapted to transmit, in real time, information or data detected by the sensors 6 to a remote station 9. Typically, the information or data transmitted to the station 9 includes details of the environment at defined locations or points within the pipeline. More specifically, the information or data identifies the level of water or other potentially corrosive agents in the chemical environment at which the carrier 3 is located at any specific time.

In use, a tool in accordance with the invention is inserted into a pipeline and is moved along the interior by using a remote system controlled at the surface; by pressurising the tool using the normal fluid carried by the pipeline; or by providing some other source of pressure.

The mobile carrier 3 moves along the pipeline and the sensors 6 measure the chemical conditions at different locations. The conditions measured can be, but are not limited to, those relating to the presence of water in the fluid being conducted in the pipe. The level of water in the oil can be calculated and an assessment of the possibility of corrosion made.

The measurement taken by the sensors can then be stored ready for retrieval when the tool has completed its sweep or can be instantly relayed to a remote processor. On the basis of the measurements taken, assessments may be made as to the likelihood of corrosion occurring.

Further modifications and improvements may be incorporated without departing from the scope of the invention herein intended.

Claims:

1. Apparatus for detecting a chemical environment in a pipeline that is likely to cause corrosion of the pipeline wall, wherein the apparatus includes sensors mounted on a mobile carrier moveable within the pipeline.

2. Apparatus as claimed in Claim 1 wherein the carrier is a pipeline pig.

3. Apparatus as claimed in Claims 1 or 2 wherein the sensors are mounted in cavities disposed at the circumference of the peripheral wall of the carrier.

4. Apparatus as claimed in any of the preceding Claims wherein the apparatus further includes means for communicating information or data detected by the sensors to a remote location outwith the pipeline.

5. Apparatus as claimed in any of the preceding Claims wherein the movement of the pig is controlled via the flow of fluid through the pipe exerting a force on the pig.

6. Apparatus as claimed in Claims 1-4 wherein the movement of the carrier may be controlled via an external means, for example via the use of a remote control or by the application of an external force.

7. Apparatus as claimed in any of the preceding Claims wherein the sensors are electro-chemical sensors.

8. A method of monitoring the likelihood of corrosive activity in a pipeline or other tubing, the method comprising the steps of positioning one or more electrochemical sensors internally in the pipeline or tubing and detecting the nature of the chemical environment therein.

9. A method as claimed in Claim 8 wherein the method further involves the movement of the sensors throughout the pipeline to obtain a more complete appraisal of the pipeline condition.